An emergent constraint on transient warming from simulated historical warming in CMIP6 models

Femke J. M. M. Nijsse, Peter M. Cox, and Mark S. Williamson
University of Exeter, College of Engineering, Mathematics and Physical Science, United Kingdom of Great Britain and Northern Ireland (f.j.m.m.nijsse@exeter.ac.uk)

The transient climate response (TCR), transient warming for a doubling of CO2, contributes the biggest uncertainty to estimates of the carbon budgets consistent with the Paris targets. In the IPCC 5th Assessment Report (AR5), the stated ‘likely’ range of TCR was given as 1.0 to 2.5K, with a central estimate which was broadly consistent with the ensemble mean of the CMIP5 Earth System Models (ESMs) available at the time (1.8 +/- 0.4 K). Many of the latest CMIP6 ESMs have larger climate sensitivities, with 6 of 23 models having TCR values above 2.5 K, and an ensemble mean TCR of 2.1 +/- 0.4 K. On the face of it, these latest ESM results suggest that the IPCC likely range of TCRE may need revising upwards, which would cast further doubt on the feasibility of the Paris targets.

We analyse the CMIP6 models through an emergent constraint approach which relates the value of TCR to the global warming from 1970 onwards. We confirm a consistent emergent constraint on TCR when we apply the same method to CMIP5 model. Our emergent constraint on TCR benefits from both the large range of TCR values across the CMIP6 models, and also from the extension of the historical simulations into a period when the uncertain changes in aerosol forcing have had a far less significant impact on the trend in global warming.

We show that rather than increasing the uncertainty in climate sensitivity, the CMIP6 models help to further constrain the likely range of TCR to 1.5-2.2 K. In CMIP6, diagnosed emissions at carbon doubling was found to be independent of TCR, so that a constraint on TCR directly leads to a constrained estimate of TCRE, with a likely range of 1.3 – 2.0 K per EgC.